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A Technique for Computation of Star Magnitudes Relative to an Optical Sensor

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PREFACE

The work described in this report was performed by the Guidance and Control Division of the Jet Propulsion Laboratory, in support of the Mariner Mars 1971 Canopus Star Tracker Calibration and Operational Software (celestial reference) Program.

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ABSTRACT

The theory and techniques used to compute star magnitudes relative to any optical detector (such as the Mariner Mars 1971 Canopus star tracker) are described here. Results are given relative to various star detectors.

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I. INTRODUCTION

Optical sensors are used on spacecraft to provide spacecraft attitude reference information. One such sensor, a star tracker, was used by the Mariner 9 spacecraft to acquire a star (usually Canopus) for use as the spacecraft roll attitude reference. In order to determine the orientation of the spacecraft, the information telemetered from the attitude reference sensor was compared to the output of an UNIVAC 1108 computer program. This program, CELREF (celestial reference), was written to simulate the voltage output of any optical sensor relative to celestial objects which appear within its field of view. Simulation of the output of an optical sensor is dependent upon knowledge of the magnitudes of stars relative to the optical sensor.

This report discusses the techniques used to compute for CELREF usage the magnitudes of stars relative to any desired optical sensor.

II. STAR MAGNITUDES AND FLUX RATIOS RELATIVE TO A STAR DETECTOR

A star magnitude relative to some detector, such as the Canopus star tracker, is an indication of the response of the detector to the star intensity. This relationship is given by

$$D = C_D - 2.5 \log_{10} \Phi_D \tag{1}$$

where D is the magnitude of the star relative to the detector, Φ_D is the response of the detector to the star intensity, and C_D is a constant associated with the photometric system of the detector. The response of the detector to a given luminous intensity is given by

$$\Phi_D = \int_0^\infty f(\lambda) D(\lambda) d\lambda \tag{2}$$

where $f(\lambda)$ is the monochromatic flux at wavelength λ of the radiating star, and $D(\lambda)$ is the relative response function (sensitivity function) of the detector. The relative response function defines the spectral region over which the detector is sensitive. This function is usually defined in terms of arbitrary units as a function of wavelength (cm x 10^4). See Tables 1 and 2 for the relative response of two detectors (Mariner 1971 Canopus tracker and Pioneer F star sensor).

Combining Eqs. (1) and (2), we obtain

$$D = C_D - 2.5 \log_{10}\left[\int_0^\infty f(\lambda)D(\lambda)d\lambda\right] \tag{3}$$

Thus the magnitude of a celestial body relative to a given detector is dependent upon that spectral region over which the detector is sensitive. The magnitude of a given star, for instance, will differ depending upon the particular instrument to which it is referenced.

If the function $f(\lambda)$ was known for each object the detector would see during a specific mission, then the detector magnitudes could be determined using Eq. (3). This information is not always available and would not be desirable even if available, owing to the time-consuming process of computing $\int_0^\infty f(\lambda)D(\lambda)d\lambda$ for each star. It is advantageous to determine some relationship between the detector magnitude of a star and its magnitude relative to published photometric systems such as the Johnson-Morgan (JM) UBV system. The UBV system is singled out because of the large number of stars whose magnitudes in this system have been published.

The relationship between the detector system and the Johnson-Morgan system may be expressed in two forms:

$$\Phi_D = C_1\Phi_U + C_2\Phi_B + C_3\Phi_V \tag{4}$$

or

$$D - V = C_4(B - V) + C_5(U - B) \tag{5}$$

where the C's in Eqs. (4) and (5) are coefficients relating parameters in the Johnson-Morgan system to that of the detector system; Φ_D, Φ_U, Φ_B, and Φ_V are responses of the detector, ultraviolet (U), blue (B), and visual (V) systems. The B - V (blue magnitude - visual magnitude) and B - U (ultraviolet magnitude — blue magnitude) are the Johnson-Morgan color indices. D - V is the color index relating detector magnitude and Johnson-Morgan V magnitude (Refs. 1-3).

Eq. 2 gives the general relationship of detector response to the luminous intensity of a star and the spectral response of the detector. Thus, the Johnson-Morgan response may be given as:

$$\Phi_U = \int_0^\infty f(\lambda)U(\lambda)d\lambda \tag{6}$$

$$\Phi_B = \int_0^\infty f(\lambda)B(\lambda)d\lambda \tag{7}$$

$$\Phi_V = \int_0^\infty f(\lambda)V(\lambda)d\lambda \tag{8}$$

where $f(\lambda)$ is the luminous intensity of some star, and $U(\lambda)$, $B(\lambda)$ and $V(\lambda)$ are the relative response functions of the Johnson-Morgan U, B, and V detectors, respectively. Tables 3, 4, and 5 present the tabulated data for the UBV relative response functions (Ref. 1).

Considering Eq. (1), we may write the Johnson-Morgan magnitudes as:

$$U = C_U - 2.5 \log_{10}\Phi_U \tag{9}$$

$$B = C_B - 2.5 \log_{10}\Phi_B \tag{10}$$

$$V = C_V - 2.5 \log_{10}\Phi_V \tag{11}$$

where C_U, C_B, and C_V are constants relating JM detector responses to magnitude. Table 6 presents the spectral characteristics (relative luminous intensity) of the star Canopus (Ref. 1). Knowing the JM magnitude of Canopus, U = -0.52, B = -0.56 and V = -0.72, and performing the integration of Eqs. 6, 7, and 8, we find the values of C_U, C_B, and C_V to be

$$C_U = -30.890600 \tag{12}$$

$$C_B = -29.283269 \tag{13}$$

$$C_V = -29.998474 \tag{14}$$

A. Flux Fit

In order to determine the best set of coefficients of Eq. (4), it is necessary to investigate a large number of stars covering the whole spectrum. This is not feasible, since sufficient spectral knowledge is known only for a limited number of stars. However, if it is assumed that a star may be approximated as a black body radiating at some temperature T, the "stars" covering that portion of the spectrum which includes the region of the detector and the defining JM filters may be used to derive a "best" set of coefficients to Eq. (4). Thus, using the method of weighted least squares, the coefficients C_1, C_2, and C_3 may be found using the family of equations generated by a discrete set of black body temperatures (T_i, i = 1, 2, ...). The family of equations is represented by

$$\int_0^\infty BB_{T_i}(\lambda)D(\lambda)d\lambda = W_i\left[C_1\int_0^\infty BB_{T_i}(\lambda)U(\lambda)d\lambda + C_2\int_0^\infty BB_{T_i}(\lambda)B(\lambda)d\lambda + C_3\int_0^\infty BB_{T_i}(\lambda)V(\lambda)d\lambda\right] \tag{15}$$

where

$$BB_{T_i}(\lambda) = \frac{E_1}{(\lambda T_i)^5\left(e^{E_2/\lambda T_i} - 1\right)} \tag{16}$$

is the normalized Planck function at temperature T_i and

$$W_i = \int_0^\infty BB_{T_i}(\lambda)D(\lambda)d\lambda$$

serves as the weighting factor for each equation. This weight, W_i, gives more importance to those "stars" whose radiating spectral region corresponds to that of the detector.

Finally, in order to relate detector flux to detector magnitude, Eq. (1), the constant C_D is evaluated using the definition that a "star" having a black-body temperature T_S will appear to have the same magnitude relative to the detector as it has with a given JM detector. The JM detector (U, B, or V) is selected such that

$$\int_0^\infty D(\lambda)JM(\lambda)d\lambda \tag{17}$$

is maximum. The black-body temperature T_S is now found such that

$$\frac{1}{D_{max}}\int_0^\infty BB_{T_S}(\lambda)D(\lambda)d\lambda = \frac{1}{JM_{max}}\int_0^\infty BB_{T_S}(\lambda)JM(\lambda)d\lambda \tag{18}$$

where

$$D_{max} = \max\left[\int_0^\infty BB_T(\lambda)D(\lambda)d\lambda\right]$$

over all T, and

$$JM_{max} = \max\left[\int_0^\infty BB_T(\lambda)JM(\lambda)d\lambda\right]$$

over all T. Thus, assume that the JM magnitude selected is the Blue magnitude, which is the case for the Canopus star tracker; then

$$\begin{aligned} C_D &= D + 2.5\log_{10}\Phi_D \\ &= (C_B - 2.5\log_{10}\Phi_B) + 2.5\log_{10}(C_1\Phi_U + C_2\Phi_B + C_3\Phi_V) \\ &= C_B + 2.5\log_{10}\left(C_1\frac{\Phi_U}{\Phi_B} + C_2 + C_3\frac{\Phi_V}{\Phi_B}\right) \end{aligned} \tag{19}$$

where

$$\Phi_U = \int_0^\infty = BB_{T_S}(\lambda)U(\lambda)d\lambda \tag{20}$$

$$\Phi_B = \int_0^\infty BB_{T_S}(\lambda)B(\lambda)d\lambda \tag{21}$$

$$\Phi_V = \int_0^\infty BB_{T_S}(\lambda)V(\lambda)d\lambda \tag{22}$$

The magnitude of a star having the Johnson-Morgan magnitudes U, B, and V is

$$D = C_D - 2.5 \log_{10} C_1 10^{0.4(C_U-U)} + C_2 10^{0.4(C_B-U)} + C_3 10^{0.4(C_V-V)} \tag{23}$$

A parameter used primarily with star trackers or sensors to indicate the brightness of a star is a value called the "Canopus ratio" of the star. The Canopus ratio of a star is defined to be the ratio of the flux of the star relative to the detector to that of the star Canopus relative to the same detector. Thus,

$$CR = \frac{\Phi_D(\text{star})}{\Phi_D(\text{Canopus})} \tag{24}$$

Equation (24) written in terms of the solution to Eq. (4) is

$$CR = \frac{C_1 10^{0.4(C_U-U_S)} + C_2 10^{0.4(C_B-B_S)} + C_3 10^{0.4(C_V-V_S)}}{C_1 10^{0.4(C_U-U_C)} + C_2 10^{0.4(C_B-B_C)} + C_3 10^{0.4(C_V-V_C)}} \tag{25}$$

B. Color Index Fit

The solution of the coefficients to Eq. (5) is found in a manner similar to that of Eq. (4). Rewriting Eq. (5), we obtain

$$C_D - 2.5 \log_{10}(\Phi_D) - C_V + 2.5 \log_{10}(\Phi_V) =$$

$$C_4 C_B - 2.5 \log_{10}(\Phi_B) - C_V + 2.5 \log_{10}(\Phi_V)$$

$$+ C_5 C_U - 2.5 \log_{10}(\Phi_U) - C_B + 2.5 \log_{10}(\Phi_B) \tag{26}$$

Collecting terms, we obtain

$$C_D - C_V - 2.5 \log_{10}\left(\frac{\Phi_D}{\Phi_V}\right) = C_4 C_B - C_V - 2.5 \log_{10}\left(\frac{\Phi_B}{\Phi_V}\right) + C_5 C_U - C_B - 2.5 \log_{10}\left(\frac{\Phi_U}{\Phi_B}\right) \quad (27)$$

If a "star" has a black-body temperature T_S (as previously defined), the magnitude of the "star" relative to the detector is equal to the magnitude of the "star" relative to the appropriate Johnson-Morgan detector. The parameter C_D is found through this definition. Thus, assuming that the appropriate JM detector was the Blue, then

$$D - B = 0 \quad (28)$$

which follows

$$C_D - 2.5 \log_{10}\left(\Phi_{D_{T_S}}\right) = C_B - 2.5 \log_{10}\left(\Phi_{B_{T_S}}\right) \quad (29)$$

and

$$C_D = C_B - 2.5 \log_{10}\left(\frac{\Phi_{B_{T_S}}}{\Phi_{D_{T_S}}}\right) \quad (30)$$

By use of Eq. (15) over a sufficient range of black-body temperatures and the method of weighted least squares (see Section II-A), a "best" set of coefficients may be found for Eq. (27).

Thus

$$D = C_4(B - V) + C_5(U - B) + V$$

and

$$CR = 10^{0.4(C_D - D_S - C_D + D_C)} = 10^{0.4(D_C - D_S)}$$

III. RESULTS AND CONCLUSIONS

In order to evaluate the relative merits of Eqs. (4) and (5) to represent any detector, the following detectors were simulated (in terms of relative response functions) to determine associated sets of coefficients for Eqs. (4) and (5):

(1) Mariner 1971 Canopus tracker (CT).

(2) Pioneer F star sensor (SS).

(3) Johnson-Morgan ultraviolet (U) detector.

(4) Johnson-Morgan blue (B) detector.

(5) Johnson-Morgan visual (V) detector.

Using the derived detector relationships to Johnson-Morgan U, B, and V magnitudes, the detector Canopus ratios and detector magnitudes were calculated for 46 brightest stars for which Johnson-Morgan U, B, and V values were available.

The results of the study are present in Tables 7 through 17. The data included in each table is defined as follows:

Column 1: Running number.

Column 2: Proper name of star.

Column 3: Star designation, see Tables 18 and 19 for explanation of terms.

Columns 4-6: Johnson-Morgan UBV magnitudes.

Columns 7-9: Canopus ratios relative to the UBV filters, respectively.

Column 10: Canopus ratio of the star relative to the detector.

Column 11: Deviation of the determined Canopus ratio (Column 9) from that of the standard value. Table 20 lists the standard Canopus ratio values for each detector studied.

Column 12: Percentage Canopus ratio deviation.
$CRPC = |CR - CRA|/CRA.$

Column 13: Magnitude of the star relative to the detector.

Column 14: Deviation of the determined magnitude (Column 12) from that of the standard value. Table 20 lists the standard magnitude values for each detector studied.

Column 15: Percentage magnitude deviation.
$DMPC = |DM - DMA|/|DMA|$.

The Mariner 1971 Canopus star tracker and the Pioneer F star sensor represent two spectral response regions which differ radically relative to the Johnson-Morgan U, B, and V filters. The region represented by the Mariner 1971 Canopus star tracker spans that covered by the UBV region, while that of the Pioneer F is outside the UBV region, in the infrared region. Tables 7 through 10 show the results of fitting the Mariner 1971 Canopus tracker in terms of the Johnson-Morgan UBV magnitudes. Tables 11 through 14 give the results of fitting the Pioneer F star sensor. In order to achieve the confidence of the Pioneer sensor fit similar to that obtained for the Mariner 1971 Canopus star tracker, it would be necessary to extend the relationship between the detector and the Johnson-Morgan UBV magnitudes to include measurements taken in the red and infrared regions such as R and I magnitudes. This would be possible by including the relative response functions representing the R and I magnitudes into Eqs. (4) and (5). Tables 15 through 17 present the results of fitting U-B, B-U, and V-U as a function of B-V, U-V, and U-B, respectively.

It should be added that the technique represented by Eq. (4) failed to provide a realistic fit (negative detector fluxes resulted) for those detectors whose spectral response range did not fall within the spectral range of the Johnson-Morgan filters used to represent the detector. Thus, as a general tool, Eq. (5) should be used to represent any detector and Eq. (4) saved only for those detectors whose spectral response regions are totally covered by the response regions of the defining Johnson-Morgan filters.

Finally, it should be noted that, in general, the more Johnson-Morgan or other photometric system magnitudes used to express the detector the better the results in the prediction of star magnitudes relative to the detector. Best results are obtained when the photometric system magnitudes chosen completely span the spectral response of the given detector. Thus for the Mariner 1971 Canopus tracker, the Johnson-Morgan UBV system is

fully adequate as a defining system. The Johnson UBVRI system or at least the VRI system would be needed to define the Pioneer star sensor to the degree that the Canopus tracker is defined by the UBV system.

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2. Melbourne, W. G., "Basic Astronomical Information Pertaining to the Problem of Stellar Identification," Technical Memo 312-10, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 13, 1960 (a JPL internal report).

3. Elliott, S., "Determination of Star/Canopus Ratios and Positions of Brightest Stars as Seen by Canopus Sensor," Engineering Memo, Jet Propulsion Laboratory, Pasadena, Calif., July 30, 1963 (a JPL internal report).

Table 1. Normalized relative response function for Canopus tracker SN/003 — Tube S11

WAVELENGTH Cm x 10^4	RELATIVE RESPONSE	WAVELENGTH Cm x 10^4	RELATIVE RESPONSE
.29	0.0	.4480	1.000
.3321	.0916	.4708	.9616
.3242	.1442	.4836	.9136
.3265	.1923	.4927	.8655
.3298	.2404	.5019	.8174
.3320	.2885	.5093	.7693
.3341	.3366	.5166	.7212
.3366	.3847	.5241	.6731
.3403	.4327	.5317	.6251
.3448	.4808	.5378	.5770
.3504	.5289	.5440	.5289
.3568	.5770	.5504	.4808
.3657	.6251	.5580	.4327
.3748	.6731	.5643	.3847
.3819	.7212	.5720	.3366
.3898	.7693	.5792	.2885
.3979	.8174	.5864	.2404
.4063	.8655	.5942	.1923
.4145	.9136	.6002	.1442
.4200	.9464	.6083	.0962
.4251	.9616	.6600	0.0

Table 2. Normalized relative response function for Pioneer F star sensor PN F

WAVELENGTH Cm X 10^4	RELATIVE RESPONSE	WAVELENGTH Cm X 10^4	RELATIVE RESPONSE
.34	0.000	.79	1.0
.40	.130	.90	.76
.46	.265	.95	.49
.50	.370	.975	.32
.60	.620	1.0	.20
.70	.850	1.1	.04

Table 3. Johnson-Morgan ultraviolet (U) bandpass relative response function

WAVELENGTH Cm X 10^4	RELATIVE RESPONSE	WAVELENGTH Cm X 10^4	RELATIVE RESPONSE
.2941	0.0	.3750	2.2351
.3030	.0660	.3800	1.9168
.3125	.3460	.3846	1.4260
.3226	.7770	.3850	1.3735
.3333	1.3000	.3900	1.0245
.3400	1.6191	.3950	.6244
.3448	1.8130	.4000	.1970
.3500	1.9905	.4050	.0967
.3571	2.1780	.4100	.0317
.3600	2.2326	.4150	.0020
.3700	2.3299	.4167	0.0
.3704	2.3300		

Table 4. Johnson-Morgan visual (V) bandpass relative response function

WAVELENGTH Cm X 10^4	RELATIVE RESPONSE	WAVELENGTH Cm X 10^4	RELATIVE RESPONSE
.4762	0.0	.5556	2.4860
.4800	.0344	.5600	2.3401
.4850	.0829	.5700	2.0319
.4878	.1120	.5714	1.9900
.4900	.1361	.5800	1.7584
.4950	.6109	.5882	1.5180
.5000	.9930	.5900	1.4626
.5100	1.8994	.6000	1.1109
.5128	2.1040	.6060	.9300
.5200	2.5502	.6250	.4730
.5263	2.7890	.6452	.1830
.5300	2.7976	.6667	.0990
.5400	2.8080	.6897	.0490
.5405	2.8080	.7143	.0210
.5500	2.6805	.7407	0.0

Table 5. Johnson-Morgan blue (B) bandpass relative response function

WAVELENGTH Cm X 10^{4}	RELATIVE RESPONSE	WAVELENGTH Cm X 10^{4}	RELATIVE RESPONSE
.3571	0.0	.4545	2.6830
.3700	.0663	.4550	2.6713
.3704	.0750	.4600	2.5447
.3750	.2032	.4650	2.3652
.3800	.3339	.4700	2.2103
.3846	.6400	.4750	2.0531
.3850	.6722	.4762	2.0150
.3900	1.1497	.4800	1.8935
.3950	2.0717	.4850	1.7271
.4000	2.5230	.4878	1.6400
.4050	2.6345	.4900	1.5731
.4100	2.7509	.4950	1.4316
.4150	2.8725	.5000	1.2860
.4167	2.9150	.5100	.9929
.4200	2.9452	.5128	.9100
.4250	2.9793	.5200	.6800
.4300	2.9996	.5263	.5050
.4348	3.0060	.5300	.4136
.4350	3.0060	.5400	.2088
.4400	2.9835	.5405	.2000
.4450	2.9194	.5500	.0592
.4500	2.8137	.5556	0.0

Table 6. Relative spectral energy distribution (SED) of Canopus

WAVELENGTH Cm X 10^{4}	RELATIVE SED	WAVELENGTH Cm X 10^{4}	RELATIVE SED
.28	.250	.470	.839
.30	.263	.475	.818
.32	.275	.480	.787
.34	.289	.485	.713
.35	.296	.490	.722
.36	.307	.495	.763
.37	.393	.500	.761
.375	.539	.510	.735
.380	.690	.520	.709
.385	.897	.530	.682
.390	.960	.540	.660
.395	.935	.550	.638
.400	.914	.560	.617
.405	.993	.570	.597
.410	.945	.580	.577
.415	.959	.590	.558
.420	1.000	.600	.539
.425	.985	.620	.502
.430	.882	.640	.467
.435	.850	.660	.434
.440	.917	.680	.402
.445	.904	.700	.372
.450	.888	.720	.343
.455	.876	.740	.316
.460	.864	.760	.291
.465	.856	.780	.267

Table 7. Mariner 71 CT color index fit: D-V=A*(B-V)+B*(U-B)

MARINER 71 CT COLOR INDEX FIT: D-V=A*(B-V)+B*(U-B)

A= -.10962246 B=-1.00416450 C= .00000000

CUB= -30.890600 CBB= -29.283369 CVB= -29.998474 CDB= -29.877784

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.247	.00000	.00000	-1.457	.000	.00000
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.578	.000	.00000
3	ARCTURUS	16 ALP BOO	2.440	1.160	-.050	.065	.201	.540	.225	.00000	.00000	1.040	.000	.00000
4	VEGA	3 ALP LYR	.054	.044	.044	.539	.573	.495	.564	.00000	.00000	.044	.000	.00000
5	CAPELLA	13 ALP AUR	1.292	.642	.062	.168	.275	.487	.293	.00000	.00000	.755	.000	.00000
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.517	.00000	.00000	.138	.000	.00000
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.300	.00000	.00000	.731	.000	.00000
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.429	.00000	.00000	.341	.000	.00000
9	HADAR	BET CEN	-.610	.570	.610	1.066	.425	.294	.406	.00000	.00000	.400	.000	.00000
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.258	.243	.00000	.00000	.957	.000	.00000
11	BETELGEUSE	23 ALP ORI		2.660	.600		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.278	2.383	.858	.012	.066	.234	.077	.00000	.00000	2.212	.000	.00000
13	SPICA	67 ALP VIR	-.212	.728	.968	.763	.305	.211	.292	.00000	.00000	.758	.000	.00000
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.058	.00000	.00000	2.513	.000	.00000
15	POLLUX	79 BET GEM	2.996	2.146	1.146	.039	.083	.179	.090	.00000	.00000	2.033	.000	.00000
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.189	.00000	.00000	1.233	.000	.00000
17	DENEB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.173	.00000	.00000	1.329	.000	.00000
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.224	.00000	.00000	1.047	.000	.00000
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.356	.00000	.00000	.545	.000	.00000
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.185	.00000	.00000	1.255	.000	.00000
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.176	.00000	.00000	1.308	.000	.00000
22	CASTOR	80 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.134	.00000	.00000	1.607	.000	.00000
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	.157	.00000	.00000	1.434	.000	.00000
24	BELLATRIX	29 GAM ORI	.545	1.415	1.635	.375	.162	.114	.156	.00000	.00000	1.443	.000	.00000
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.142	.00000	.00000	1.538	.000	.00000
26	GACRUX	GAM CRU	5.040	3.280	1.660	.006	.029	.112	.034	.00000	.00000	3.095	.000	.00000
27	MIAPLACIDUS	BET CAR	1.658	1.678	1.678	.130	.127	.110	.125	.00000	.00000	1.678	.000	.00000
28	ALNILAM	40 EPS ORI	.474	1.514	1.694	.400	.148	.108	.142	.00000	.00000	1.538	.000	.00000
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.133	.00000	.00000	1.611	.000	.00000
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.393	.145	.103	.139	.00000	.00000	1.566	.000	.00000
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.116	.00000	.00000	1.763	.000	.00000
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.047	.00000	.00000	2.733	.000	.00000
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.075	.00000	.00000	2.225	.000	.00000
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.136	.00000	.00000	1.588	.000	.00000
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.110	.00000	.00000	1.818	.000	.00000
36	WEZEN	25 DEL CMA	2.998	2.508	1.938	.053	.059	.095	.063	.00000	.00000	2.433	.000	.00000
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.076	.00000	.00000	2.216	.000	.00000
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.091	.036	.00000	.00000	3.045	.000	.00000
39	ALKAID	65 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.121	.00000	.00000	1.714	.000	.00000
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.100	.00000	.00000	1.925	.000	.00000
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.068	.118	.00000	.00000	1.745	.000	.00000
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.099	.00000	.00000	1.930	.000	.00000
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.030	.00000	.00000	3.229	.000	.00000
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.115	.00000	.00000	1.770	.000	.00000
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.029	.00000	.00000	3.256	.000	.00000
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.036	.00000	.00000	3.028	.000	.00000

	AVERAGE	RMS	1 SIGMA
CR-CRA	.00000	.00000	.00000
(CR-CRA)/CRA	.00000	.00000	.00000
CM-CMA	.00000	.00000	.00000
(CM-CMA)/CMA	.00000	.00000	.00000

Table 8. Mariner 71 CT color index fit: D-V=A*(U-B)

MARINER 71 CT COLOR INDEX FIT: D-V=A*(U-B)
A=-1.045C9990 B= .00000000 C= .00000000
CU= -30.390600 CB= -29.283269 CV= -29.998474 CC= -29.809598

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.277	.02955	.01315	-1.455	.002	.00118
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.562	.016	.02753
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.055	.201	.540	.212	-.01356	.06015	1.123	.083	.08006
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.573	.00854	.01514	.044	-.000	.00931
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.280	-.01350	.04605	.822	.067	.08890
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.513	-.00443	.00856	.163	.025	.18288
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.292	-.00809	.02701	.777	.046	.06243
8	ACHERNAR	ALP ERI	-.390	.320	.490	.855	.445	.328	.432	.00282	.00657	.350	.009	.02575
9	HADAR	BET CEN	-.610	.370	.610	1.036	.425	.294	.407	.00078	.00193	.414	.014	.03448
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.258	.242	-.00144	.00592	.980	.022	.02334
11	BETELGEUSE	58 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.278	2.388	.858	.012	.066	.234	.071	-.00507	.06627	2.303	.090	.04084
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.293	.00101	.00344	.770	.012	.01605
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.051	-.00667	.11496	2.661	.148	.05909
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.086	-.00477	.05283	2.108	.075	.03681
16	FOMALHAUT	24 ALP PSA	1.315	1.243	1.153	.185	.190	.178	.190	.00155	.00823	1.240	.007	.00568
17	DENEB	50 ALP CYG	1.093	1.338	1.248	.225	.174	.163	.172	-.00060	.00348	1.349	.020	.01481
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.224	.00041	.00181	1.061	.014	.01332
19	ACRUX	ALP CRU	-.450	.610	.790	.938	.373	.249	.358	.00240	.00674	.553	.009	.01580
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.187	.00220	.01187	1.258	.003	.00246
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.176	.00038	.00217	1.321	.014	.01035
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.135	.00161	.01207	1.610	.003	.00179
23	SHAULA	32 LAM SCO	.507	1.407	1.617	.388	.163	.116	.157	.00030	.00192	1.448	.014	.00964
24	BELLATRIX	24 GAM ORI	.545	1.419	1.635	.375	.162	.114	.156	.00063	.00407	1.454	.011	.00797
25	ELNATH	112 BET TAU	1.052	1.522	1.652	.239	.147	.113	.144	.00133	.00934	1.544	.006	.00378
26	GACRUX	GAM CRU	5.040	3.280	1.580	.006	.029	.112	.031	-.00269	.07925	3.201	.106	.03410
27	MIAPLACIDUS	BET CAR	1.603	1.673	1.673	.130	.127	.110	.127	.00194	.01552	1.677	-.001	.00049
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.108	.142	-.00091	.00637	1.561	.023	.01485
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.135	.00167	.01253	1.614	.002	.00148
30	ALNITAK	50 ZET ORI	.479	1.559	1.749	.398	.145	.103	.138	-.00057	.00411	1.587	.020	.01300
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.118	.00215	.01850	1.759	-.004	.00233
32	DUBHE	50 ALP UMA	3.743	2.353	1.793	.020	.043	.099	.045	-.00271	.05713	2.813	.080	.02919
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.074	-.00146	.01930	2.266	.037	.01663
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.127	.00112	.00826	1.594	.007	.00439
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.112	.00143	.01298	1.820	.002	.00105
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.039	.059	.095	.060	-.00212	.03394	2.486	.053	.02195
37	SARGAS	THE SCO	2.410	2.260	1.860	.087	.074	.093	.075	-.00152	.01988	2.253	.038	.01702
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.091	.032	-.00362	.10187	3.178	.133	.04353
39	ALKAID	85 ETA UMA	1.010	1.690	1.980	.244	.126	.091	.122	.00100	.00823	1.721	.007	.00409
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.102	.00235	.02358	1.916	-.009	.00468
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.119	.00091	.00772	1.752	.008	.00433
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.101	.00158	.01590	1.929	-.001	.00064
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.028	-.00219	.07303	3.327	.098	.03043
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.115	.00018	.00155	1.785	.014	.00803
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.029	.083	.027	-.00186	.06342	3.343	.087	.02673
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.034	-.00208	.05752	3.108	.080	.02649

	AVERAGE	RMS	1 SIGMA
CR-CRA	-.00027	.00595	.00595
(CR-CRA)/CRA	.02499	.03784	.02842
CM-CMA	.03307	.05125	.03915
(CM-CMA)/CMA	.02400	.03957	.03147

Table 9. Mariner 71 CT color index fit: D-V=A*(U-B)

MARINER 71 CT COLOR INDEX FIT: D-V=A*(U-V)

A= -.52260133 B= .00000000 C= .00000000

CU= -30.390600 CB= -29.283269 CV= -29.998474 CC= -30.328014

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.439	-1.457	-1.457	2.484	2.285	1.972	2.193	-.05446	.02423	-1.477	-.020	.01388
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.625	-.047	.08110
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	.197	-.02321	.12515	1.138	.098	.09453
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.538	-.02621	.04647	.049	.005	.10950
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.183	.275	.487	.309	.01632	.05566	.649	-.106	.14003
6	RIGEL	19 BET ORI	-.537	.153	.153	1.016	.528	.448	.662	.14445	.27926	-.176	-.314	2.27746
7	PROCYON	10 ALP CMI	.737	.777	.357	.300	.292	.371	.335	.03559	.11879	.562	-.169	.23084
8	ACHERNAR	ALP ERI	-.350	.520	.490	.855	.945	.328	.518	.08933	.20828	.089	-.252	.73888
9	HADAR	BET CEN	-.610	.370	.610	1.066	.425	.294	.548	.14212	.34936	.028	-.373	.93052
10	ALTAIR	53 ALP AQL	1.055	.963	.753	.235	.241	.256	.246	.00327	.01343	.899	-.061	.06400
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.276	2.388	.858	.012	.066	.234	.057	-.01978	.25833	2.490	.278	.12548
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.387	.09528	.32613	.405	-.353	.46598
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.063	.00488	.08405	2.378	-.134	.05352
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.087	-.00349	.03868	2.029	-.004	.00198
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.181	-.00739	.03915	1.229	-.003	.00283
17	DENEB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.190	.01769	.10241	1.176	-.153	.11490
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.305	.08126	.36273	.664	-.383	.36583
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.375	.249	.469	.11300	.31773	.198	-.346	.63599
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.200	.01521	.08223	1.122	-.133	.10573
21	ADHARA	26 EPS CMA	.350	1.230	1.300	.445	.184	.129	.233	.05714	.32446	.956	-.352	.26909
22	CASTOR	68 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.129	-.00475	.03552	1.599	-.008	.00472
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.398	.165	.116	.207	.04983	.31778	1.087	-.346	.24164
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.201	.04595	.29543	1.115	-.328	.22727
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.161	.01890	.13271	1.356	-.182	.11841
26	GACRUX	GAM CRU	5.040	3.260	1.660	.006	.029	.112	.028	-.00635	.18695	3.273	.178	.05746
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.678	.130	.127	.110	.119	-.00635	.05069	1.688	.010	.00574
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.146	.108	.202	.05959	.41826	1.112	-.426	.27713
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.148	.01455	.10927	1.452	-.159	.09895
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.196	.05755	.41465	1.143	-.423	.27034
31	ALIOTH	77 EPS UMA	1.736	1.760	1.790	.120	.118	.099	.109	-.00712	.06147	1.785	.022	.01249
32	DUBHE	50 ALP UMA	3.743	2.653	1.793	.020	.043	.099	.046	-.00160	.03377	2.724	-.010	.00350
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.073	-.00215	.02855	2.213	-.015	.00691
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.176	.04009	.29457	1.260	-.327	.20608
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.109	-.00071	.00641	1.778	-.040	.02194
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.039	.059	.095	.062	-.00034	.00541	2.392	-.041	.01684
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.080	.00332	.04348	2.122	-.093	.04201
38	AVIOR	EPS CAR	3.480	3.190	1.880	.026	.032	.091	.050	.01418	.39887	2.634	-.411	.13506
39	ALKAID	85 ETA UMA	1.010	1.690	1.830	.244	.126	.091	.146	.02478	.20445	1.465	-.249	.14520
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.084	-.01552	.15564	2.062	.137	.07106
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.144	.02606	.22134	1.481	-.264	.15125
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.094	-.00545	.05489	1.944	.014	.00748
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.026	-.00436	.14530	3.352	.124	.03829
44	MIRZAM	2 BET CMA	.780	1.740	1.980	.310	.120	.083	.156	.04093	.35585	1.393	-.377	.21316
45	ALPHARD	30 ALP HYA	3.151	3.421	1.991	.005	.026	.083	.023	-.00675	.23061	3.494	.238	.07303
46	HAMAL	12 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.033	-.00350	.09704	3.092	.064	.02112

		AVERAGE	RMS	1 SIGMA
CR-CRA		.02237	.04833	.04284
(CR-CRA)/CRA		.16569	.21099	.13063
CM-CMA		-.12750	.22028	.18935
(CM-CMA)/CMA		.20643	.42233	.36845

Table 10. Mariner 71 CT color index fit: D-V=A*(B-V)

MARINER 71 CT COLOR INDEX FIT: D-V=A*(B-V)

A= -.11069033 B= .00000000 C= .00000000

CU= -30.890500 CG= -29.283269 CV= -29.998474 CC= -29.880753

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRG	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.248	.00029	.00013	-1.457	-.000	.00012
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.578	-.000	.00006
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	.225	-.00077	.00342	1.044	.004	.00355
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.564	-.00004	.00007	.044	.000	.00095
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.293	-.00025	.00085	.756	.001	.00117
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.526	.448	.519	.00130	.00252	.135	-.003	.02004
7	PROCYON	10 ALP CMI	.737	.777	.357	.300	.292	.371	.300	.00013	.00042	.730	-.000	.00067
8	ACHERNAR	ALP ERI	-.380	.320	.490	.855	.445	.328	.430	.00100	.00234	.339	-.003	.00754
9	HADAR	BET CEN	-.610	.370	.610	1.086	.425	.294	.408	.00140	.00345	.397	-.004	.00943
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.258	.243	-.00001	.00003	.957	-.000	.00000
11	BETELGEUSE	53 ALP ORI		2.660	.900		.052	.247						
12	ALDEBARAN	67 ALP TAU	4.278	2.368	.953	.012	.066	.234	.076	-.00042	.00548	2.218	.006	.00268
13	SPICA	67 ALP VIR	-.212	.723	.963	.753	.305	.211	.293	.00096	.00330	.755	-.004	.00476
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.058	-.00017	.00267	2.516	.003	.00123
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.090	-.00019	.00212	2.035	.002	.00112
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.169	-.00004	.00020	1.233	.000	.00014
17	DENEB	50 ALP CYG	1.098	1.358	1.248	.225	.174	.163	.173	.00017	.00099	1.328	-.001	.00084
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.225	.00060	.00355	1.043	-.004	.00372
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.357	.00118	.00333	.541	-.004	.00669
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.185	.00023	.00126	1.253	-.001	.00112
21	ACHARA	26 EPS CMA	.350	1.280	1.500	.445	.184	.129	.177	.00057	.00324	1.304	-.004	.00272
22	CASTOR	60 ALP GEM	1.620	1.610	1.560	.139	.136	.120	.134	-.00000	.00004	1.607	.000	.00000
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.338	.163	.116	.157	.00050	.00318	1.430	-.003	.00243
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.156	.00047	.00305	1.439	-.003	.00232
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.143	.00024	.00170	1.536	-.002	.00122
26	GACRUX	GAM CRU	5.040	3.260	1.660	.008	.029	.112	.034	-.00017	.00488	3.100	.005	.00170
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.678	.130	.127	.110	.125	-.00001	.00011	1.678	.000	.00005
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.410	.148	.108	.143	.00053	.00375	1.534	-.004	.00267
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.213	.138	.103	.133	.00021	.00156	1.610	-.002	.00107
30	ALNITAK	50 ZET ORI	.472	1.535	1.749	.398	.145	.103	.139	.00053	.00379	1.562	-.004	.00265
31	ALIOTH	77 EPS UMA	1.730	1.760	1.790	.120	.119	.099	.116	-.00002	.00015	1.763	.000	.00007
32	DUBHE	50 ALP UMA	3.742	2.653	1.793	.020	.043	.099	.047	-.00010	.00221	2.735	.002	.00086
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.075	-.00007	.00093	2.230	.001	.00044
34	REGOR	GAM VEL	.623	1.553	1.833	.346	.143	.095	.137	.00043	.00317	1.584	-.003	.00219
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.915	1.935	.128	.112	.095	.110	.00004	.00033	1.817	-.000	.00022
36	MEZEN	25 DEL CMA	2.988	2.508	1.838	.039	.059	.095	.062	-.00007	.00113	2.434	.001	.00049
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.076	-.00001	.00014	2.216	.000	.00005
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.091	.036	.00002	.00046	3.045	-.001	.00018
39	ALKAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.121	.00029	.00236	1.711	-.003	.00151
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.100	-.00012	.00119	1.927	.001	.00065
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.118	.00029	.00250	1.742	-.003	.00157
42	ALHENA	24 GAM GEM	1.930	1.930	1.930	.102	.101	.087	.099	-.00001	.00015	1.930	.000	.00006
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.030	-.00012	.00411	3.233	.004	.00137
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.115	.00040	.00349	1.767	-.004	.00216
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.029	-.00015	.00498	3.261	.005	.00165
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.036	-.00011	.00298	3.031	.003	.00106

	AVERAGE	RMS	1 SIGMA
CR-CRA	.00020	.00049	.00043
(CR-CRA)/CRA	.00204	.00257	.00156
CM-CMA	-.00041	.00280	.00277
(CM-CMA)/CMA	.00216	.00399	.00335

Table 11. Pioneer F SS color index fit: D-V=A*(B-V)+B*(U-B)

PIONEER F SS COLOR INDEX FIT: D-V=A*(B-V)+B*(U-B)

A=-1.16119530 B=-1.68567900 C= .00000000

CU= -30.890600 CB= -29.283269 CV= -29.998474 CC= -29.673412

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	1.828	.00000	.00000	-1.428	.000	.00000
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.773	.000	.00000
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	1.366	.00000	.00000	-1.112	.000	.00000
4	VEGA	3 ALP LYR	.054	.044	.044	.509	.573	.495	.474	.00000	.00000	.037	.000	.00000
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.691	.00000	.00000	-.372	.000	.00000
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.278	.00000	.00000	.616	.000	.00000
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.378	.00000	.00000	.282	.000	.00000
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.449	.328	.200	.00000	.00000	.977	.000	.00000
9	HADAR	BET CEN	-.610	.370	.610	1.036	.425	.294	.145	.00000	.00000	1.321	.000	.00000
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.256	.265	.00000	.00000	.668	.000	.00000
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	67 ALP TAU	4.279	2.366	.858	.012	.066	.234	.522	.00000	.00000	-.685	.000	.00000
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.107	.00000	.00000	1.651	.000	.00000
14	ANTARES	21 ALP SCO	4.020	2.720	.860	.015	.049	.229	.651	.00000	.00000	-.308	.000	.00000
15	POLLUX	73 BET GEM	3.996	2.146	1.146	.039	.085	.179	.339	.00000	.00000	.402	.000	.00000
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.165	.190	.178	.180	.00000	.00000	1.090	.000	.00000
17	DENEB	50 ALP CYG	1.093	1.338	1.248	.225	.174	.163	.135	.00000	.00000	1.398	.000	.00000
18	MIMOSA	BET CRU	.005	1.015	1.205	.617	.234	.161	.078	.00000	.00000	1.998	.000	.00000
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.124	.00000	.00000	1.493	.000	.00000
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.110	.00000	.00000	1.622	.000	.00000
21	ADHARA	26 EPS CMA	.380	1.280	1.500	.445	.184	.129	.067	.00000	.00000	2.166	.000	.00000
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.129	.136	.120	.110	.00000	.00000	1.568	.000	.00000
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	.061	.00000	.00000	2.269	.000	.00000
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.061	.00000	.00000	2.267	.000	.00000
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.077	.00000	.00000	2.009	.000	.00000
26	GACRUX	GAM CRU	3.040	3.280	1.660	.006	.029	.112	.411	.00000	.00000	.192	.000	.00000
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.678	.130	.127	.110	.106	.00000	.00000	1.664	.000	.00000
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.108	.052	.00000	.00000	2.436	.000	.00000
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.072	.00000	.00000	2.083	.000	.00000
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.049	.00000	.00000	2.510	.000	.00000
31	ALIOTH	77 EPS UMA	1.730	1.760	1.790	.120	.118	.099	.095	.00000	.00000	1.781	.000	.00000
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.193	.00000	.00000	1.012	.000	.00000
33	MIREAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.127	.00000	.00000	1.465	.000	.00000
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.049	.00000	.00000	2.509	.000	.00000
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.129	.112	.095	.085	.00000	.00000	1.907	.000	.00000
36	WEZEN	25 DEL CMA	2.998	2.508	1.836	.039	.059	.095	.136	.00000	.00000	1.394	.000	.00000
37	SARGAS	THE SCO	2.410	2.360	1.860	.057	.074	.093	.103	.00000	.00000	1.693	.000	.00000
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.091	.125	.00000	.00000	1.484	.000	.00000
39	ALKAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.055	.00000	.00000	2.377	.000	.00000
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.104	.00000	.00000	1.683	.000	.00000
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.052	.00000	.00000	2.446	.000	.00000
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.065	.00000	.00000	1.909	.000	.00000
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.266	.00000	.00000	.664	.000	.00000
44	MIRZAM	2 BET CMA	.750	1.740	1.960	.310	.120	.083	.041	.00000	.00000	2.698	.000	.00000
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.292	.00000	.00000	.563	.000	.00000
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.186	.00000	.00000	1.056	.000	.00000

	AVERAGE	RMS	1 SIGMA
CR-CRA	.00000	.00000	.00000
(CR-CRA)/CRA	.00000	.00000	.00000
CM-CMA	.00000	.00000	.00000
(CM-CMA)/CMA	.00000	.00000	.00000

Table 12. Pioneer F SS color index fit: D-V=A*(B-V)

PIONEER F SS COLOR INDEX FIT: D-V=A*(B-V)

A= -1.59663080 B= .00000000 C= .00000000

CV= -30.890600 CB= -29.283269 CV= -29.998474 CC= -30.104093

NO.	PROPER NAME	DESIGNATION	U	B	V	CRL	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	DMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	1.806	-.02250	.01231	-1.457	-.029	.02016
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.815	-.042	.05463
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.066	.201	.540	.971	-.39517	.28919	-.784	.328	.29524
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.453	-.02096	.04421	.044	.007	.18460
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.684	-.00707	.01922	-.403	-.031	.08343
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.405	.12709	.45674	.165	-.451	.73209
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.429	.04960	.13113	.106	-.176	.62323
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.274	.07416	.37169	.591	-.385	.39453
9	HADAR	BET CEN	-.610	.370	.610	1.006	.425	.294	.236	.09044	.62214	.753	-.567	.42968
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.256	.268	.00243	.00917	.616	-.052	.07808
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.278	2.388	.858	.012	.066	.234	.496	-.42528	.46146	-.055	.630	.91988
13	SPICA	67 ALP VIR	-.212	.729	.369	.753	.305	.211	.170	.06236	.58167	1.111	-.540	.32705
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.577	-.07481	.11482	-.218	.090	.29281
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.093	.179	.294	-.05429	.16026	.549	.147	.36667
16	FOMALHAUT	24 ALP PSA	1.313	1.247	1.153	.165	.190	.178	.171	-.00825	.04593	1.099	.009	.00809
17	DENEB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.157	.02171	.16039	1.194	-.204	.14574
18	MIMOSA	BET CRU	.005	1.015	1.165	.617	.234	.161	.128	.05037	.64655	1.414	-.584	.29215
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.195	.07145	.57629	.957	-.536	.35914
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.128	.01790	.16258	1.417	-.206	.12685
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.105	.03832	.57440	1.631	-.535	.24699
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.130	.120	.112	-.00378	.03265	1.562	-.006	.00396
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.383	.163	.116	.095	.03407	.56088	1.742	-.526	.23178
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.093	.03195	.52546	1.766	-.501	.22088
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.096	.01882	.24409	1.730	-.279	.13907
26	GACRUX	GAM CRU	5.040	3.260	1.660	.006	.029	.112	.249	-.16191	.39390	.693	.501	2.61047
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.678	.130	.127	.110	.101	-.00532	.05023	1.679	.014	.00824
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.108	.090	.03777	.72581	1.801	-.635	.26059
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.087	.01520	.21099	1.832	-.250	.12009
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.084	.03534	.72685	1.874	-.635	.25317
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.089	-.00596	.06159	1.308	.027	.01503
32	DUBHE	50 ALP UMA	3.743	2.353	1.793	.020	.043	.099	.162	-.03115	.16126	1.161	.149	.14695
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.117	-.01053	.08276	1.517	.052	.03519
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.075	.02613	.53697	2.000	-.509	.20283
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.915	1.835	.128	.112	.095	.086	.00139	.01636	1.847	-.060	.03139
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.039	.059	.095	.125	-.01040	.07656	1.438	.044	.03174
37	SARGAS	THE SCO	2.410	2.260	1.860	.057	.074	.093	.106	.00280	.02715	1.621	-.071	.04214
38	AVIOR	EPS CAR	3.460	3.150	1.880	.026	.032	.091	.172	.04648	.37157	1.098	-.385	.25968
39	ALKAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.075	.02030	.36935	1.993	-.384	.16136
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.083	-.02079	.19961	1.882	.199	.11856
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.072	.02056	.39876	2.039	-.407	.16624
42	ALHENA	24 GAM GEM	1.980	1.930	1.930	.100	.101	.087	.080	-.00475	.05621	1.930	.021	.01077
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.177	-.08896	.33435	1.064	.400	.60161
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.067	.02586	.63241	2.123	-.574	.21291
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.168	-.12427	.42532	1.122	.559	.99385
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.140	-.04601	.24800	1.323	.267	.25312

	AVERAGE	RMS	1 SIGMA
CR-CRA	-.01332	.10066	.09977
(CR-CRA)/CRA	.28667	.38614	.22776
DM-DMA	-.13593	.36305	.33664
(DM-DMA)/DMA	.29139	.50845	.41667

Table 13. Pioneer F SS color index fit: D-V=A*(U-B)

PIONEER F SS COLOR INDEX FIT: D-V=A*(U-B)

A=-2.91738060 B= .00000000 C= .00000000

CU= -30.890600 CB= -29.283269 CV= -29.998474 CC= -29.616467

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	DMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	1.977	.14849	.08123	-1.376	.052	.03622
2	CANOPUS	ALP CAR	-.520	-.500	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.637	.137	.17656
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	1.737	.37005	.27030	-1.236	-.124	.11119
4	VEGA	3 ALP LYR	.034	.044	.044	.589	.573	.495	.544	.06966	.14693	.025	-.012	.33161
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.567	-.12415	.17961	-.021	.351	.94407
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.151	-.12751	.45825	1.418	.802	1.30276
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.277	-.10140	.26809	.758	.475	1.68313
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.127	-.07262	.36397	1.605	.628	.64274
9	HADAR	BET CEN	-.610	.370	.610	1.035	.425	.294	.070	-.07526	.51777	2.249	.928	.70297
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.258	.255	-.01061	.04001	.849	.181	.27077
11	BETELGEUSE	53 ALP ORI		2.560	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.278	2.388	.658	.012	.066	.234	1.736	.81486	.88419	-1.236	-.551	.80531
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.054	-.05311	.49538	2.530	.879	.53240
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.451	-.20030	.30744	.227	.535	1.73837
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.346	.00702	.02073	.516	.114	.28422
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.200	.02067	.11505	1.109	.018	.01677
17	DENEB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.106	-.02918	.21555	1.798	.400	.28619
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.037	-.04120	.52889	2.952	.954	.47738
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.064	-.06015	.48514	2.351	.857	.57406
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.092	-.01780	.16168	1.950	.328	.20216
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.034	-.03300	.49472	3.044	.878	.40516
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.129	.01281	.11071	1.591	.023	.01436
23	SHAULA	51 LAM SCO	.507	1.407	1.617	.388	.163	.116	.031	-.02968	.48863	3.133	.865	.38126
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.033	-.02829	.46524	3.083	.816	.36000
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.058	-.01948	.25256	2.462	.453	.22523
26	GACRUX	GAM CRU	5.040	3.260	1.660	.009	.029	.112	.607	.19592	.47663	-.095	-.287	1.49248
27	MIAPLACIDUS	BET CAR	1.696	1.678	1.678	.130	.127	.110	.123	.01695	.16001	1.640	-.025	.01480
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.146	.108	.022	-.03005	.57750	3.508	1.072	.44003
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.057	-.01513	.20996	2.475	.392	.19842
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.021	-.02789	.57351	3.571	1.062	.42306
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.114	.01882	.19784	1.722	-.059	.03339
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.194	.00033	.00172	1.147	.135	.13307
33	MIRFAK	33 ALP PER	2.863	2.283	1.803	.053	.073	.098	.133	.00565	.04443	1.554	.089	.06097
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.026	-.02244	.46124	3.317	.808	.32206
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.088	.00290	.03426	2.007	.100	.05242
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.039	.059	.095	.131	-.00467	.03434	1.568	.174	.12515
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.090	-.01275	.12356	1.972	.280	.16526
38	AVIOR	EPS CAR	3.460	2.190	1.880	.026	.032	.091	.047	-.07763	.62054	2.672	1.189	.80111
39	ALKAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.035	-.01965	.35755	2.994	.617	.25955
40	MENKALINAN	64 BET AUR	2.240	1.930	1.900	.079	.101	.090	.163	.05843	.56101	1.338	-.347	.20622
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.032	-.01957	.37945	3.101	.655	.26762
42	ALPHECA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.099	.01464	.17325	1.872	-.037	.01935
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.351	.08502	.31953	.500	-.165	.24767
44	MIRZAM	2 BET CMA	.750	1.740	1.960	.310	.120	.083	.020	-.02140	.52321	3.638	.941	.34873
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.506	.21335	.73021	.104	-.459	.81528
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.219	.03359	.18103	1.012	-.044	.04180

	AVERAGE	RMS	1 SIGMA
CR-CRA	.01809	.15206	.15098
(CR-CRA)/CRA	.31319	.37980	.21485
DM-DMA	.35728	.57308	.44308
(DM-DMA)/DMA	.42141	.60079	.42821

Table 14. Pioneer F SS color index fit: D-V=A*(U-V)

PIONEER F SS COLOR INDEX FIT: D-V=A*(U-V)

A=-1.38675250 B= .00000000 C= .00000000

CU= -30.890600 CB= -29.283269 CV= -29.998474 CD= -29.887875

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	1.809	-.01939	.01061	-1.441	-.013	.00879
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.797	-.024	.03121
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	1.220	-.14674	.10739	-1.013	.099	.08920
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.462	-.01170	.02467	.040	.003	.00848
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.702	-.01109	.01605	-.414	-.041	.11125
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.326	.04766	.17126	.420	-.196	.31800
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.403	.02430	.06425	.191	-.092	.32483
8	ACHERNAR	ALP ERI	-.350	.320	.490	.955	.445	.328	.227	.02700	.13533	.815	-.162	.16578
9	HADAR	BET CEN	-.610	.370	.610	1.086	.425	.294	.177	.03178	.21863	1.082	-.239	.18083
10	ALTAIR	53 ALP AQL	1.053	.963	.753	.235	.241	.258	.267	.00167	.00630	.637	-.031	.04634
11	BETELGEUSE	58 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.278	2.380	.858	.012	.066	.234	.736	-.18549	.20127	-.465	.220	.32118
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.129	.02201	.20529	1.424	-.227	.13739
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.045	.229	.653	.00137	.00211	-.334	-.026	.08579
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.323	-.01604	.04735	.431	.029	.07097
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.176	-.00405	.02254	1.091	.001	.00057
17	DENEB	50 ALP CYG	1.098	1.339	1.248	.225	.174	.163	.144	.00874	.06455	1.306	-.092	.06584
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.096	.01762	.22619	1.752	-.246	.12290
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.149	.02503	.20191	1.270	-.224	.14987
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.117	.00643	.05843	1.537	-.086	.05288
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.080	.01359	.20366	1.941	-.225	.10404
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.114	-.00215	.01857	1.565	-.004	.00241
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	.073	.01212	.19954	2.046	-.222	.09774
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.072	.01138	.18720	2.057	-.210	.09283
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.084	.00690	.08945	1.892	-.117	.05832
26	GACRUX	GAM CRU	5.040	3.280	1.660	.006	.029	.112	.347	-.06434	.15654	.353	.161	.83672
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.678	.130	.127	.110	.103	-.00290	.02735	1.670	.006	.00359
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.106	.065	.01324	.25447	2.166	-.270	.11095
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.078	.00548	.07601	1.979	-.104	.04978
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.061	.01233	.25356	2.240	-.269	.10738
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.092	-.00318	.03339	1.794	.013	.00716
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.184	-.00888	.04596	1.039	.027	.02664
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.124	-.00341	.02677	1.470	.005	.00363
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.145	.095	.058	.00918	.18875	2.297	-.212	.08444
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.085	.00010	.00115	1.881	-.025	.01331
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.039	.059	.095	.133	-.00242	.01778	1.389	-.005	.00334
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.105	.00204	.01977	1.647	-.045	.02681
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.091	.149	.02401	.19194	1.269	-.215	.14475
39	ALKAID	65 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.062	.00735	.13374	2.216	-.160	.06749
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.094	-.01004	.09638	1.769	.086	.05105
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.059	.00742	.14391	2.276	-.170	.06955
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.082	-.00254	.03003	1.918	.009	.00470
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.233	-.03352	.12598	.786	.122	.18376
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.050	.00908	.22199	2.456	-.242	.08964
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.239	-.05281	.18076	.755	.192	.34184
46	RAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.169	-.01625	.08760	1.131	.075	.07143

	AVERAGE	RMS	1 SIGMA
CR-CRA	-.00504	.04035	.04003
(CR-CRA)/CRA	.10659	.13443	.08192
CM-CMA	-.06992	.14786	.13029
(CM-CMA)/CMA	.11150	.17891	.13991

Table 15. Ultraviolet (U) color index fit: D-B=A*(B-V)

ULTRAVIOLET (U) COLOR INDEX FIT: D-B=A*(B-V)

A= .23857354 B= .00000000 C= .00000000

CU= -30.890600 CB= -29.283269 CV= -29.938474 CC= -30.925627

NO.	PROPER NAME	DESIGNATION	U	B	V	CRL	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	DMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.366	-.09748	.03956	-1.457	.042	.02802
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.522	-.002	.00352
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.063	.201	.540	.159	.09372	1.43159	1.473	-.967	.39613
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.485	.594	.00445	.00755	.044	-.010	.19519
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.240	.05145	.27302	1.028	-.264	.20427
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.550	-.46627	.45902	.128	.665	1.23879
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.276	-.02439	.08127	.877	.090	.11461
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.476	-.37700	.44090	.279	.629	1.79841
9	HADAR	BET CEN	-.610	.370	.610	1.036	.425	.294	.464	-.62280	.57325	.313	.923	1.51269
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.258	.238	.00289	.01232	1.038	-.015	.01437
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	67 ALP TAU	4.278	2.386	.858	.012	.066	.234	.049	.03694	3.06688	2.753	-1.525	.35647
13	SPICA	67 ALP VIR	-.212	.728	-.368	.753	.305	.211	.333	-.41960	.55724	.671	.883	4.16388
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.034	.01843	1.20637	3.159	-.861	.21419
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.085	.179	.069	.02955	.75323	2.385	-.611	.20409
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.165	.190	.178	.193	.00812	.04395	1.264	-.049	.03696
17	DENEB	50 ALP CYG	1.093	1.338	1.248	.225	.174	.163	.177	-.04952	.21534	1.359	.261	.23813
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.257	-.36007	.58397	.955	.950	190.07132
19	ACRUX	ALP CRU	-.450	.610	.700	.938	.373	.249	.411	-.52642	.56148	.443	.893	1.98489
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.202	-.07571	.27261	1.215	.344	.39467
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.200	-.24498	.55098	1.228	.868	2.40976
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.139	.00013	.00093	1.617	-.003	.00175
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.383	.163	.116	.177	-.21111	.54364	1.357	.850	1.67633
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.176	-.19867	.52982	1.363	.818	1.50003
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.157	-.08281	.34585	1.491	.459	.44475
26	GACRUX	GAM CRU	5.040	3.280	1.660	.006	.029	.112	.021	.01515	2.53731	3.666	-1.374	.27252
27	MIAPLACIDUS	BET CAR	1.699	1.678	1.678	.130	.127	.110	.132	.00219	.01698	1.678	-.020	.01179
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.106	.160	-.24078	.60148	1.471	.997	2.10350
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.219	.138	.103	.147	-.07081	.32457	1.557	.424	.37442
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.358	.145	.103	.157	-.24154	.60617	1.489	1.010	2.10835
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.123	.00234	.02360	1.753	-.027	.01526
32	DUBHE	50 ALP UMA	3.743	2.653	1.793	.020	.043	.099	.035	.01568	.79520	3.106	-.637	.17021
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.068	.01465	.27486	2.398	-.265	.09969
34	REGOR	GAM VEL	.033	1.553	1.833	.346	.143	.095	.157	-.18846	.54502	1.488	.853	1.34787
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.123	.112	.095	.117	-.01092	.08551	1.810	.095	.05553
36	WEZEN	25 DEL CMA	2.998	2.506	1.838	.039	.055	.095	.053	.01383	.35310	2.668	-.330	.11013
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.071	.00335	.04978	2.355	-.055	.02264
38	AVIOR	EPS CAR	3.480	3.190	1.880	.026	.032	.091	.025	-.00102	.04003	3.503	.043	.01229
39	ALKAID	85 ETA UMA	1.010	1.690	1.830	.244	.126	.091	.136	-.10839	.44358	1.645	.635	.62839
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.104	.02515	.31949	1.937	-.303	.13520
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.133	-.11406	.46253	1.672	.672	.67229
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.105	.00268	.02629	1.930	-.030	.01531
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.020	.01292	1.91033	3.743	-1.162	.23684
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.131	-.17918	.57716	1.683	.933	1.24366
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.019	.01391	2.57973	3.765	-1.386	.26916
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.026	.01414	1.17533	3.433	-.946	.19763

		AVERAGE	RMS	1 SIGMA
CR-CRA		-.10064	.19604	.16823
(CR-CRA)/CRA		.58442	.91080	.69658
DM-DMA		.07991	.70524	.70070
(DM-DMA)/DMA		4.67324	28.35518	27.93327

Table 16. Blue (B) color index fit: D-U=A*(U-V)

BLUE (B) COLOR INDEX FIT: D-U=A*(U-V)

A= -.46998501 B= .00000000 C= .00000000

CU= -30.890600 CB= -29.283269 CV= -29.998474 CC= -30.980290

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.219	-.06581	.02881	-1.479	-.022	.01528
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.614	-.054	.09642
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	.176	-.02497	.12400	1.270	.090	.07605
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.543	-.03047	.05315	.049	.005	.12046
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.294	.01941	.07062	.714	-.128	.15212
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.691	.16281	.30823	-.213	-.346	2.59933
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.331	.03959	.13563	.585	-.192	.24722
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.545	.10048	.22599	.045	-.275	.86004
9	HADAR	BET CEN	-.610	.370	.610	1.086	.425	.294	.588	.16294	.38372	-.037	-.407	1.09897
10	ALTAIR	53 ALP AQL	1.053	.983	.753	.235	.241	.258	.245	.00381	.01578	.912	-.071	.07222
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.278	2.388	.858	.012	.066	.234	.049	-.01765	.26660	2.671	.283	.11836
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.414	.10900	.35696	.343	-.385	.52942
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.055	.00579	.11867	2.544	-.176	.06462
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.080	-.00259	.03130	2.127	-.019	.00907
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.182	-.00635	.04395	1.238	-.005	.00418
17	DENEB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.194	.01954	.11225	1.168	-.170	.12668
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.328	.09332	.39807	.597	-.418	.41164
19	ACRUX	ALP CRU	-.450	.510	.790	.933	.373	.249	.503	.12943	.34676	.133	-.377	.73964
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.207	.01653	.08684	1.097	-.144	.11636
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.249	.06528	.35545	.896	-.384	.30017
22	CASTOR	66 ALP GEM	1.620	1.610	1.560	.139	.136	.120	.130	-.00553	.04077	1.601	-.009	.00547
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	.220	.05688	.34812	1.029	-.378	.26888
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.215	.05235	.32278	1.057	-.358	.25280
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.168	.02094	.14247	1.323	-.199	.13049
26	GACRUX	GAM CRU	5.040	3.260	1.660	.006	.029	.112	.024	-.00546	.18750	3.451	.171	.05227
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.670	.130	.127	.110	.120	-.00735	.05776	1.689	.011	.00632
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.108	.216	.06845	.46234	1.047	-.467	.30820
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.213	.138	.103	.154	.01599	.11616	1.420	-.173	.10879
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.358	.145	.103	.211	.06621	.45764	1.076	-.463	.30092
31	ALIOTH	77 EPS UMA	1.730	1.760	1.790	.120	.118	.099	.110	-.00825	.06992	1.785	.025	.01403
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.042	-.00108	.02503	2.827	-.026	.00928
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.071	-.00197	.02708	2.259	-.024	.01059
34	REGOR	GAM VEL	.633	1.553	1.623	.346	.143	.095	.189	.04581	.32071	1.197	-.356	.22925
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.123	.112	.095	.111	-.00107	.00953	1.771	-.044	.02402
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.029	.059	.095	.059	.00006	.00109	2.453	-.055	.02200
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.078	.00383	.05147	2.152	-.108	.04801
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.091	.046	.01487	.47039	2.717	-.473	.14814
39	ALKAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.154	.02787	.22137	1.419	-.271	.16042
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.084	-.01730	.17145	2.080	.150	.07783
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.152	.02940	.24007	1.432	-.288	.16722
42	ALHENA	24 GAM GEM	1.960	1.950	1.930	.102	.101	.087	.095	-.00629	.06235	1.946	.016	.00824
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.022	-.00376	.14347	3.509	.114	.03362
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.167	.04695	.39049	1.328	-.412	.23673
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.019	-.00607	.23732	3.661	.240	.07020
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.029	-.00306	.09396	3.212	.053	.01682

	AVERAGE	RMS	1 SIGMA
CR-CRA	.02579	.05501	.04859
(CR-CRA)/CRA	.18076	.23144	.14454
CM-CMA	-.14488	.24933	.20292
(CM-CMA)/CMA	.23264	.46332	.42365

Table 17. Visual (V) color index fit: D-U=A*(U-B)

VISUAL (V) COLOR INDEX FIT: D-U=A*(U-B)

A=-1.80468540 B= .00000000 C= .00000000

CU= -30.890600 CB= -29.283269 CV= -29.998474 CC= -30.245220

NO.	PROPER NAME	DESIGNATION	U	B	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	DMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.150	.17829	.09043	-1.423	.034	.02320
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.000	1.000	1.000	1.000	.00000	.00000	-.592	.128	.17751
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.050	.065	.201	.540	.497	-.04202	.07789	.166	.216	4.31689
4	VEGA	3 ALP LYR	.054	.044	.044	.569	.573	.496	.561	.06595	.13329	.036	-.008	.18293
5	CAPELLA	13 ALP AUR	1.232	.842	.062	.188	.275	.487	.373	-.11407	.23440	.480	.418	6.73873
6	RIGEL	19 BET ORI	-.537	.133	.153	1.016	.528	.448	.312	-.13547	.30271	.672	.519	3.39394
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.285	-.08539	.23026	.769	.412	1.15392
8	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.263	-.06542	.19941	.859	.369	.75362
9	HADAR	BET CEN	-.610	.370	.610	1.086	.425	.294	.199	-.09442	.32141	1.159	.549	.89965
10	ALTAIR	53 ALP AQL	1.083	.983	.753	.235	.241	.256	.247	-.01065	.04135	.927	.174	.23062
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.276	2.388	.656	.012	.066	.234	.201	.02709	.11587	.867	.009	.01022
13	SPICA	67 ALP VIR	-.212	.728	.963	.753	.305	.211	.148	-.06358	.30099	1.485	.517	.53367
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.124	-.10502	.45842	1.674	.794	.90187
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.151	-.02851	.15903	1.462	.316	.27561
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.194	.01614	.09058	1.187	.034	.02919
17	DENEB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.141	-.02176	.13333	1.531	.283	.22690
18	MIMOSA	BET CRU	.065	1.015	1.265	.617	.234	.161	.108	-.05306	.33020	1.828	.563	.44501
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.178	-.07104	.28543	1.283	.493	.62366
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.140	-.00798	.05377	1.539	.188	.13901
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.090	-.03928	.30350	2.020	.520	.34700
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.133	.01231	.10241	1.602	.022	.01389
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	.081	-.03481	.29957	2.131	.514	.31812
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.083	-.03168	.27719	2.115	.480	.29373
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.099	-.01330	.11821	1.916	.264	.16004
26	GACRUX	GAM CRU	5.040	3.280	1.660	.005	.029	.112	.104	-.00751	.06726	1.863	.203	.12253
27	MIAPLACIDUS	BET CAR	1.698	1.678	1.673	.130	.127	.110	.125	.01557	.14172	1.662	.016	.00959
28	ALNILAM	40 EPS ORI	.474	1.514	1.694	.400	.146	.108	.066	-.04176	.38583	2.351	.657	.38789
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.213	.138	.103	.095	-.00844	.08162	1.963	.220	.12636
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.084	-.03889	.37791	2.392	.643	.36774
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.119	.099	.116	.01721	.17371	1.744	-.046	.02575
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.081	-.01781	.18029	2.137	.344	.19166
33	MIRFAK	33 ALP PER	2.693	2.283	1.803	.053	.073	.098	.094	-.00409	.04178	1.977	.174	.09659
34	REGOR	GAM VEL	.633	1.553	1.653	.346	.143	.095	.070	-.02513	.26392	2.293	.460	.25122
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.129	.112	.096	.101	.00608	.06396	1.895	.060	.03295
36	WEZEN	25 DEL CMA	2.998	2.508	1.638	.039	.059	.095	.063	-.01207	.12727	2.114	.276	.14995
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.081	-.01210	.13021	2.139	.279	.15014
38	AVIOR	EPS CAR	3.460	2.190	1.880	.026	.032	.091	.038	-.05370	.08860	2.973	1.093	.58121
39	ALKAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.074	-.01738	.19054	2.237	.357	.19006
40	MENKALINAN	34 BET AUR	2.240	1.930	1.900	.079	.101	.090	.123	.03375	.37698	1.680	-.220	.11553
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.070	-.01819	.20692	2.300	.380	.19767
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.100	.01308	.15022	1.906	-.024	.01251
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.078	-.00884	.10201	2.180	.245	.12642
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.056	-.02715	.32642	2.537	.557	.28123
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.089	.00638	.07672	2.029	.048	.02400
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.072	-.00852	.10523	2.258	.249	.12371

	AVERAGE	RMS	1 SIGMA
CR-CRA	-.02060	.05379	.04969
(CR-CRA)/CRA	.19598	.23272	.12550
DM-DMA	.30546	.39607	.25213
(DM-DMA)/DMA	.57230	1.34635	1.21865

Table 18. Computer abbreviations of Greek alphabet and lower case letters

Greek		Lower case	
Abbreviation	Symbol	Abbreviation	Letter
ALP	α	-A	a
BET	β	-B	b
GAM	γ	-C	c
DEL	δ	-D	d
EPS	ϵ	-E	e
ZET	ζ	-F	f
ETA	η	-G	g
THE	θ	-H	h
IOT	ι	-I	i
KAP	κ	-J	j
LAM	λ	-K	k
MU	μ	-L	l
NU	ν	-M	m
XI	ξ	-N	n
OMI	o	-O	o
PI	π	-P	p
RHO	ρ	-Q	q
SIG	σ	-R	r
TAU	τ	-S	s
UPS	υ	-T	t
PHI	ϕ	-U	u
CHI	χ	-V	v
PSI	ψ	-W	w
OME	ω	-X	x
		-Y	y
		-Z	z

[a]Superscripts are denoted as follows: ALP-1 implies α^1

-H-2 implies h^2

Table 19. Constellations

1.	AND	ANDROMEDA	46.	LEO	LEO
2.	ANT	ANTLIA	47.	LMI	LEO MINOR
3.	APS	APUS	48.	LEP	LEPUS
4.	AQR	AQUARIUS	49.	LIB	LIBRA
5.	AQL	AQUILA	50.	LUP	LUPUS
6.	ARA	ARA	51.	LYN	LYNX
7.	ARI	ARIES	52.	LYR	LYRA
8.	AUR	AURIGA	53.	MEN	MENSA
9.	BOO	BOOTES	54.	MIC	MICROSCOPIUM
10.	CAE	CAELUM	55.	MON	MONOCEROS
11.	CAM	CAMELOPARDALIS	56.	MUS	MUSCA
12.	CNC	CANCER	57.	NOR	NORMA
13.	CVN	CANES VENATICI	58.	OCT	OCTANS
14.	CMA	CANIS MAJOR	59.	OPH	OPHIUCHUS
15.	CMI	CANIS MINOR	60.	ORI	ORION
16.	CAP	CAPRICORNUS	61.	PAV	PAVO
17.	CAR	CARINA	62.	PEG	PEGASUS
18.	CAS	CASSIOPEIA	63.	PER	PERSEUS
19.	CEN	CENTAURUS	64.	PHE	PHOENIX
20.	CEP	CEPHEUS	65.	PIC	PICTOR
21.	CET	CETUS	66.	PSC	PISCES
22.	CHA	CHAMAELEON	67.	PSA	PISCIS AUSTRINUS
23.	CIR	CIRCINUS	68.	PUP	PUPPIS
24.	COL	COLUMBA	69.	PYX	PYXIS
25.	COM	COMA BERENICES	70.	RET	RETICULUM
26.	CRA	CORONA AUSTRALIS	71.	SGE	SAGITTA
27.	CRB	CORONA BOREALIS	72.	SGR	SAGITTARIUS
28.	CRV	CORVUS	73.	SCO	SCORPIUS
29.	CRT	CRATER	74.	SCL	SCULPTOR
30.	CRU	CRUX	75.	SCT	SCUTUM
31.	CYG	CYGNUS	76.	SCP	SERPENS CAPUT
32.	DEL	DELPHINUS	77.	SCA	SERPENS CAUDA
33.	DOR	DORADO	78.	SEX	SEXTANS
34.	DRA	DRACO	79.	TAU	TAURUS
35.	EQU	EQUULEUS	80.	TEL	TELESCOPIUM
36.	ERI	ERIDANUS	81.	TRI	TRIANGULUM
37.	FOR	FORNAX	82.	TRA	TRIANGULUM AUSTRALE
38.	GEM	GEMINI	83.	TUC	TUCANA
39.	GRU	GRUS	84.	UMA	URSA MAJOR
40.	HER	HERCULES	85.	UMI	URSA MINOR
41.	HOR	HOROLOGIUM	86.	VEL	VELA
42.	HYA	HYDRA	87.	VIR	VIRGO
43.	HYI	HYDRUS	88.	VOL	VOLANS
44.	IND	INDUS	89.	VUL	VULPECULA
45.	LAC	LACERTA			

Table 20. Standard Canopus ratios and magnitudes of stars used in conjunction with Tables 7 through 17

STAR NO.	MARINER '71 CT		PIONEER F SS		ULTRAVIOLET		BLUE		VISUAL	
	CR	MAGNITUDE	CR	MAGNITUDE	CR	MAGNITUDE	CR	MAGNITUDE	CR	MAGNITUDE
1	2.247	-1.457	1.828	-1.428	2.464	-1.499	2.285	-1.457	1.972	-1.457
2	1.000	- .578	1.000	- .773	1.000	- .520	1.000	- .560	1.000	- .720
3	.225	1.040	1.366	-1.112	.065	2.440	.201	1.180	.540	- .050
4	.564	.044	.474	.037	.589	.054	.573	.044	.495	.044
5	.293	.755	.691	- .372	.188	1.292	.275	.842	.487	.062
6	.517	.138	.278	.616	1.016	.537	.528	.133	.448	.153
7	.300	.731	.378	.282	.300	.787	.292	.777	.371	.357
8	.429	.341	.200	.977	.855	- .350	.445	.320	.328	.490
9	.406	.400	.145	1.321	1.086	- .610	.425	.370	.294	.610
10	.243	.957	.265	.668	.235	1.053	.241	.983	.258	.753
11	-	-	-	-	-	-	.052	2.660	.247	.800
12	.077	2.212	.922	- .685	.012	4.278	.066	2.388	.234	.858
13	.292	.758	.107	1.651	.753	- .212	.305	.728	.211	.968
14	.058	2.513	.651	- .308	.015	4.020	.049	2.720	.229	.880
15	.090	2.033	.339	.402	.039	2.996	.083	2.146	.179	1.146
16	.189	1.233	.180	1.090	.185	1.313	.190	1.243	.178	1.153
17	.173	1.329	.135	1.398	.225	1.098	.174	1.338	.163	1.248
18	.224	1.047	.078	1.998	.617	.005	.234	1.015	.161	1.265
19	.356	.545	.124	1.493	.938	- .450	.373	.510	.249	.790
20	.185	1.255	.110	1.622	.278	.871	.190	1.241	.148	1.351
21	.176	1.308	.067	2.166	.445	.360	.184	1.280	.129	1.500
22	.134	1.607	.116	1.568	.139	1.620	.136	1.610	.120	1.580
23	.157	1.434	.061	2.268	.388	.507	.163	1.407	.116	1.617
24	.156	1.443	.061	2.267	.375	.545	.162	1.415	.114	1.635
25	.142	1.538	.077	2.009	.239	1.032	.147	1.522	.113	1.652
26	.034	3.095	.411	.192	.006	5.040	.029	3.280	.112	1.660
27	.125	1.678	.106	1.664	.130	1.698	.127	1.678	.110	1.678
28	.142	1.538	.052	2.436	.400	.474	.148	1.514	.108	1.694
29	.133	1.611	.072	2.083	.218	1.133	.138	1.593	.103	1.743
30	.139	1.566	.049	2.510	.398	.479	.145	1.539	.103	1.749
31	.116	1.763	.095	1.781	.120	1.780	.118	1.760	.099	1.790
32	.047	2.733	.193	1.012	.020	3.743	.043	2.853	.099	1.793
33	.075	2.229	.127	1.465	.053	2.663	.073	2.283	.098	1.803
34	.136	1.588	.049	2.509	.346	.633	.143	1.553	.095	1.833
35	.110	1.818	.085	1.907	.128	1.715	.112	1.815	.095	1.835
36	.063	2.433	.136	1.394	.039	2.998	.059	2.508	.095	1.838
37	.076	2.216	.103	1.693	.067	2.410	.074	2.260	.093	1.860
38	.036	3.045	.125	1.484	.026	3.460	.032	3.190	.091	1.880
39	.121	1.714	.055	2.377	.244	1.010	.126	1.690	.091	1.880
40	.100	1.925	.104	1.683	.079	2.240	.101	1.930	.090	1.900
41	.118	1.745	.052	2.446	.247	1.000	.122	1.720	.088	1.920
42	.099	1.930	.085	1.909	.102	1.960	.101	1.930	.087	1.930
43	.030	3.229	.266	.664	.007	4.905	.026	3.395	.087	1.935
44	.115	1.770	.041	2.698	.310	.750	.120	1.740	.083	1.980
45	.029	3.256	.292	.563	.005	5.151	.026	3.421	.083	1.981
46	.036	3.028	.186	1.056	.012	4.279	.033	3.159	.081	2.009

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